CLAIMS

We claim:

1. An image sensor, comprising:

a sensor array comprising a two-dimensional array of pixel elements, said sensor array outputting digital signals as k-bit pixel data representing an image of a scene, and said sensor array generating multiple representations of said image at a plurality of exposure times; and

a data memory, in communication with said sensor array, for storing an m-bit time index value and said pixel data for each of said pixel elements, said time index value indicating one of said plurality of exposure times in which said pixel data exceeds a predetermined threshold level and for which said pixel data is stored, said time index value including a t-bit threshold indication for each of said pixel elements encoded within said m-bit time index value;

wherein said data memory includes k+t bits of memory space for each of said pixel element; said data memory stores said time index value in t bits and said k-bit pixel data for pixel data being captured in a last one of said plurality of exposure times; and said data memory stores said time index value in m-bit and stores the lower r bits, where r=k+t-m, of said pixel data for pixel data exceeding said predetermined threshold level in other exposure times.

2. The image sensor of Claim 1, wherein said sensor array is fabricated in an integrated circuit.

3. The image sensor of Claim 1, wherein said sensor array is of N by M pixels and said data memory is N by M by

k+1 bits where said time index value is in 2-bit and said threshold indicator is a first bit of said time index value.

4. The image sensor of Claim 3, wherein r=k-1.

5. The image sensor of Claim 1, wherein a first bit of said time index value represents said threshold indication.

6. The image sensor of Claim 1, wherein said sensor array further comprises a companding circuit for companding said k-bit pixel data into h bits, h being less than k; and said data memory stores said pixel data in h bits for pixel data being captured in said last one of said plurality of exposure times and stores said pixel data in h+t-m bits for pixel data exceeding said predetermined threshold level in all other exposure times.

7. The image sensor of Claim 6, wherein said companding circuit comprises a look-up table containing values for mapping a k-bit number to a h-bit number.

8. The image sensor of Claim 7, wherein h=k-1.

9. The image sensor of Claim 7, wherein said sensor array further comprises a plurality of analog-to-digital conversion (ADC) circuits, each of said plurality of ADC circuit being coupled to one or more pixel elements, and said companding circuit is coupled to said plurality of ADC circuits to cause said ADC circuits to generate said pixel data in h bits.

10. The image sensor of Claim 9, wherein said plurality of ADC circuits employs Multi-Channel Bit Serial analog-to-digital conversion technique and said companding

circuit is coupled to said plurality of ADC circuits for programming a ramp signal of each of said ADC circuits.

11. The image sensor of Claim 1, wherein said plurality of exposure times comprise any of a relatively short exposure time for capturing image information that is related to high illumination areas in said image, a relatively long exposure time for capturing image information that is related to low illumination areas in said image, and intermediate exposure times for capturing image information that is related to gradually increasing illumination areas in said image; and wherein a combination of said multiple representations of said image at a plurality of exposure time establishes a wide dynamic range for said sensor array.

12. The image sensor of Claim 1, wherein, after pixel data for a first representation of said image is read out and stored in said data memory, pixel data for a second representation of said image is selectively read out into said data memory to improve, update or enhance pixel data stored therein for each of said pixel elements.

13. The image sensor of Claim 12, wherein said selective read out of said second representation of said image is controlled by said threshold indication of said time index value for each of said pixel elements.

14. A method for generating electrical signals representing an image in a digital image sensor, comprising:

generating digital signals as k-bit pixel data at a plurality of exposure times, said pixel data being associated with each pixel element in a sensor array of pixel elements and corresponding to a level of an

analog signal indicative of a light intensity impinging on said pixel element;

determining if said pixel data of a first one of said pixel elements exceeds a predetermined threshold value;

if said pixel data exceeds said predetermined threshold value at exposure times before a last one of said plurality of exposure times, storing an m-bit time index value in a location in a data memory associated with said first one of said pixel elements to a first value indicating said exposure time; and storing the lower r bits of said pixel data in a location in said data memory, said data memory including r+m bits of memory space for each pixel element; and

if said pixel data does not exceed said predetermined threshold value, setting a portion of said time index value in said data memory associated with said first one of said pixel elements to a second value, and storing k bits of pixel data in said data memory.

15. The method of Claim 14, further comprising:

if said pixel data does not exceed said predetermined threshold value before said last one of said plurality of exposure times, storing said k bits pixel data in said data memory for pixel data recorded in said last one of said plurality of exposure times.

16. The method of Claim 14, wherein r=k-1.

17. The method of Claim 14, wherein said generating at a plurality of exposure times digital signals in k-bit as pixel data comprises companding said k-bit pixel data into h bits, h being less than k, and said storing the lower r bits

of said pixel data in said data memory comprises storing the lower h-1 bits of said pixel data.

18. The method of Claim 17, further comprising:

if said pixel data does not exceed said predetermined threshold value before said last one of said plurality of exposure times, storing said h bits pixel data in said data memory for pixel data recorded in said last one of said plurality of exposure times.

19. The method of Claim 17, wherein h=k-1.